(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁷: H04N 7/62, 5/00

(21) International Application Number: PCT/EP01/00110

(22) International Filing Date: 5 January 2001 (05.01.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
00200038.8   10 January 2000 (10.01.2000)   EP

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(81) Designated States *(national)*: BR, CN, JP, KR, PL, US.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— with international search report
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD OF SETTING A SYSTEM TIME CLOCK AT THE START OF AN MPEG SEQUENCE
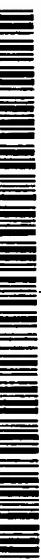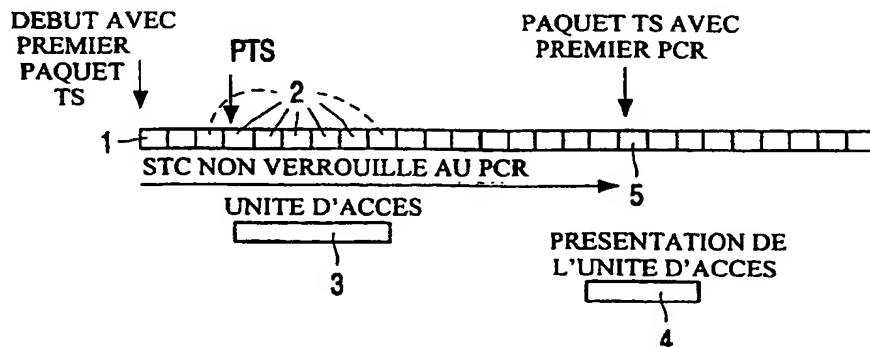
(57) Abstract: Method to enable a local system time clock counter (STC) of a receiving recording device to lock to program clock reference (PCR) information comprised in a received real time sequence of information signal packets, such as MPEG2 Transport Stream packets. The method comprising determining the number of cycles between arrival of the first information signal packet and the arrival of the information signal packet comprising the first Program Clock Reference (PCR) information. This information is stored as an attribute of the stored sequence.

Method of setting a system time clock at the start of an MPEG sequence.

The invention relates to a method according to the preamble of claim 1. The method further relates to a recording apparatus according to the preamble of claim 7 and a reproducing apparatus according to the preamble of claim 8.

Digital information signals representing a real time stream of A/V information,

5   such as an MPEG encoded Transport Stream, comprise time base information of the transmitting site. In case of an MPEG encoded Transport Stream the time base information is specified by Program Clock Reference (PCR) signals, transmitted regularly within a Transport Packet (TP). This time base information is used to lock a local clock at a receiving site to the clock at the transmitting site. However, this time base information is not sent with

10   every Transport Packet (TP). This has a consequence that at start-up a local clock may not yet be locked by this time base information. This means that it is not known, with respect to Transport Packets (TP) arriving before locking, at which instant these Transport Packets (TP) have to be decoded (in case of Access Units (AU) with a Decoding Time Stamp (DTS)) or to be presented (in case of Access Units (AU) with a Presentation Time Stamp PTS)).

15   Further, in case discontinuities occur in a real time stream due to concatenation of different streams of different programs with a mutually different time base after for instance editing, the correct timing after such a discontinuity should be restored when starting processing the Transport Packets of a second sequence. However, the Packet Arrival Time (PAT) timestamp counter will be discontinuous after such a discontinuity.

20   In consequence, amongst other things, it is an object of the invention to obviate the above-mentioned disadvantages. According to one of its aspects a method according to the invention is characterized by the characterizing part of claim 1, a recording apparatus by the characterizing part of claim 7 and a reproducing apparatus by the characterizing part of claim 8.

25   Calculating the value of System Time Clock of the first information signal packet improves the playback performance and simplifies processing during playback.

These and further aspects and advantages of the invention will be discussed in more detail hereinafter with reference to the disclosure of preferred embodiments, and in particular with reference to the appended figures that show:

Fig. 1 schematically a sequence of a stream of MPEG Transport Packets during start-up;

Fig. 2 a discontinuity between two sequences of a stream of MPEG Transport Packets;

Fig. 3 time stamp generator means in a recording/reproducing apparatus during recording according to the invention;

Fig. 4 an example of recording Transport Packets at start-up of a sequence according to the invention;

Fig. 5 time stamp generator means in a recording/reproducing apparatus during playback according to the invention,

Fig. 6 an example of recording Transport Packets during a discontinuity;

Fig. 7 shows a recording apparatus employing the time stamp generator means of Fig. 3,

Fig. 8 shows a reproducing apparatus employing the time stamp generator means of Fig. 5,

Fig. 9 illustrates an advantageous embodiment of the invention for reading data from a stream of encoded data for trickplay,

Fig. 10 illustrates a random access in a stream of MPEG 2 Transport Stream data after a PID change, and

Fig. 11 illustrates trickplay of a stream of MPEG 2 Transport stream data after a PAT/PMT change.

Fig. 1 illustrates a sequence of MPEG Transport Packets (TS packet). The sequence starts with a first TS packet 1. The TS packets 2 constitute an encoded Access Unit 3 to be presented as a decoded Presentation Unit 4 at a time specified by a corresponding Presentation Time Stamp (PTS). This Access Unit 3 is received before a local System Time Clock at a receiving site, such as a 27 MHz PLL, is locked to the time base information comprised in the stream. This Program Clock Reference (PCR) is first received with the TP packet 5. Therefore it is not known when the Access Unit 4 should be presented as the Presentation Time Stamp (PTS) points to time interval before the arrival of the first Program Clock Reference (PCR).

Fig. 2 illustrates a discontinuity in a stream of MPEG Transport Packets (TS packets). A first sequence 6 of TS packets is followed by a second sequence 7 of TS packets. Each sequence having it own time base information or Program Clock Reference (PCR). This situation might occur after editing of a stream. The Packet Arrival Time counter is therefore

5   discontinuous. The last Access Unit (AU) constituted by the TS packets 8 of the first sequence is presented as a Presentation Unit 9 seamlessly with other Presentation Units 10, 11 and 12 from the second sequence. However, the first TS packet with Program Clock Reference (PCR) of the second sequences 7 arrives with TS packet 13 while the TS packet 14 to be presented is received prior. Therefore, the local System Time Clock is not yet locked to

10   the PCR of the second sequence.

Fig. 3 illustrates time stamp generator means 15 in a recording/reproducing apparatus according to a first embodiment of the invention. A 27 MHz Voltage Controlled Oscillator 16 controls the System Time Counter (STC) 17, which is set to an arbitrary value during start-up and counts in an MPEG way (like PCR, PTS, DTS) As soon as the first

15   Program Clock Reference (PCR) information arrives, the System Time Counter (STC) 17 is set to the value of this Program Clock Reference (PCR). Further locking is achieved by a phase detector that compares the received Program Clock Reference (PCR) information with the System Time Counter (STC) value. The phase difference is used, via a Low Pass Filter (LPF) 19, to the Voltage Controlled Oscillator (VCO) 16, constituting a Phase Locked Loop

20   (PLL). The System Time Clock is used to control a binary Application Packet Arrival Time (APAT) counter 20 for generating corresponding APAT time stamps.

During start-up the APAT counter 20 starts at an arbitrary value. APAT time stamps are appended to every received TS packet. The time stamps represent the arrival time of the TS packets. The APAT[start] time stamp of the first TS packet of a sequence and also

25   the APAT[PCR] timestamp of the TS packet which contains the Program Clock Reference (PCR) is stored temporarily in memory means. The number of 27 MHz cycles between the two time stamps is calculated by subtracting APAT[start] from APAT[PCR]. With the difference the start of the System Time Counter (STC-start) is calculated by subtracting this difference from the first received PCR-value. STC-start is the value the STC-counter 17

30   would have if it were locked from the beginning. STC-start is preferably stored as segment attribute when storing the MPEG stream on a recording medium, such as a disc.

Fig. 4 shows an example of playback of Transport Packets at start-up of a sequence according to the invention. Shown are irregular received TS packets 21, the arrival time of the TS packets 21 given by the APAT time stamp. The timing between the TS

packets 21 should be kept constant on a digital interface during playback. The Start Segment 22 does not need to start with a Program Clock Reference (PCR), this information is received later with TS packet 23. The repetition frequency of the Program Clock Reference (PCR) information could be 100 ms with a recommendation of 40 ms. The received TS packets 21

5   are temporarily stored in smoothing buffer 24. This causes a start-up delay until the Presentation Unit (PU) 25 given by the Access Unit (AU) 26 comprising corresponding TS packets 21, is presented. It is noted that this delay is needed if the APAT timing of the stream is to be kept.

From the content of a smoothing buffer 24 the original timing can be

10   reconstructed during playback, which is shown with reference to Fig. 5. Fig. 5 shows time stamp generator means for generating the correct timing of a recorded stream of TS packets recorded in accordance with the invention, as illustrated with reference to Fig. 4. The disclosed embodiment has a great similarity with the embodiment disclosed in Fig. 3, reference numeral are therefore identical. The difference being the ability of setting the

15   System Time Clock (STC)-counter 17 and the Application Packet Arrival Time (APAT) counter 20. Immediately after starting, the System Time Counter (STC) 17 is set with the STC-start value, which has been stored in the segment attribute for instance, as discussed previously. From this moment the System Time Counter (STC) 17 is locked to the Program Clock Reference (PCR). The Application Packet Arrival Counter (APAT) 20 is set with the

20   Application Packet Arrival Time (APAT) time stamp from the first TS packet. TS packets are retrieved from the smoothing buffer 24 at the time which is indicated by the Application Packet Arrival Time (APAT) time stamp. It is noted that for an internal decoder it is not needed but on the interface the stream should start with an inserted Program Clock Reference (PCR) packet to replace the STC-start.

25   Fig. 6 shows an example of recording Transport Packets during a discontinuity. The Application Packet Arrival Timestamps (APAT) of the first sequence 27 and the second sequence 28 are discontinuous at the connection point. The offset between both counters should be calculated. Then the correct timing can be reconstructed in a smoothing buffer. Shown is an Access Unit (AU) 32, constituting the last segment to be

30   presented as Presentation Unit 29, from the first sequence 27. A subsequent Presentation Unit (PU) 30, corresponding to the first Access Unit (AU) 33 of the second sequence 28 follows. The Presentation Unit (PU) 29 comprises a Presentation Time Stamp PTS-1e with reference to a first local System Time Counter STC-1. The Presentation Unit (PU) 30 comprises a Presentation Time Stamp PTS-2b with reference to a second local System Time Counter

STC-2. It is assumed that the connection point is of the C-type, implying that by definition there are no buffer problems after the discontinuity, there is no overlap in APAT time stamps from a first and second segment and the presentation units 29 and 30 are presented seamlessly.

From the fact that the presentation is seamless, it is known when on the local time base STC-1, the first presentation unit 30 of the second segment should be presented : PTS-1e+T. From the first presentation unit 30 of the second segment it is known when this presentation unit should be presented on the local time base STC-2 : PTS-2b. The number of clock cycles between the arrival time of the first TS packet and the presentation time is known : PTS-2b – STC-start(2). So it can be calculated at what moment in the local time base STC-1 the local time base STC-2 should set to STC-start(2).

It is remarked that an overlap is needed for STC-1 and STC-2 in a decoder (about 1 second)

Fig. 7 shows a recording apparatus with an input terminal 34 and receiving means 35 for recording received information signals representing Transport Packets. A packet detector 36 detects the arrival of the received Transport Packets and the embedded Program Clock Reference (PCR) signals. A Time Stamp Generator 15, as disclosed with reference to Fig. 3, as locked with its local System Time Counter to the Program Clock Reference (PCR) signals. At start-up the Time Stamp Generator 15 is set to an arbitrary value for setting the local System Time Counter as disclosed with reference to Fig.3. The generated Time Stamps, together with the System Time Counter start value (STC-start), is combined with the received Transport Packets in a combining unit 38. The combined signals are channel encoded with channel encoding means 39 and recorded on a record carrier 40 by writing means 41. The record carrier may be of the disc like type in which case it is rotationally driven by rotating means 42 while a recording writing beam is displaced in a radial direction by translating means 43. The record carrier 40 may be of the optical type, such as a recordable CD, DVD. In this case the writing means 41 generates a laser beam for writing and comprises suitable focussing means. In another embodiment the record carrier 40 may be of the magnetic type, such a magnetic disc.

Fig. 8 shows a reproducing apparatus adapted to scan a recording medium 40, recorded in accordance with the method of the invention, with a reading beam with suitable reading means 44. In case if the record carrier 40 is of the optical type, such as a CD, DVD, the reading means comprises a laser beam and corresponding focussing means to scan the record carrier 40. The detected signal is channel decoded by channel decoding means 45. The

decoded Transport Packets with Time Stamps are supplied to demultiplexing means 46 for separating the Time Stamps from the Transport Packets. The Time Stamp are supplied to comparator means 38. The generated Time Stamp value generated by the Time Stamp generating means 37, such a disclosed with reference to Fig. 5, is also supplied to this

5   comparator means 8. A recorded System Time Clock start value (STC-start) is submitted to the Time Stamp generating means 37, for locking the Time Stamp Counter to this value whenever necessary, in accordance with the method according to the invention. The generated Time Stamp value is compared with the recorded and extracted Time Stamp values. When both coincide, the corresponding Transport Packet stored in buffer memory 47

10   is submitted to outputting means 48, for generating a real time stream of Transport Packets at output terminal 49.

           As mentioned before, the Transport Packets may comprise real time A/V information. A combined recording and reproducing device, such as described with reference to Fig. 7, respectively Fig. 8, may be used as a disk based video recorder. For user

15   convenience it may be allowed to a user to set marks on key points within the recorded A/V program in order to indicate key scenes, commercial ends and so on. These key points are typically chosen to be video entry points, such as I-frames in MPEG2. However, to allow the playback device to decode the video at these points, additional information is needed.

           It is remarked that a complete description of the MPEG2 format can be found

20   in the corresponding international standards ISO/IEC 13818. I-frames are intra encoded frames frames that can be decoded independently from each other, this in contrast to P-frames that are predictive encoded and need a previous P- or I-frame. Further B-frames or bi-directional frames can be distinguished that need a preceeding and succeeding I- or P-frame to encode.

25   An advantageous embodiment is obtained by storing additional information with the mark point to allow decoding at the mark point. If this is not done, it may take some time (1-2 seconds) before correct decoding begins and this part of the video will not be displayed correctly.

           For an MPEG2 Transport Stream, the mark point should store the following

30   information : the Program Clock Reference (PCR) at the entry point, the Presentation Time Stamp (PTS) of the I-frame, the Decoding Time Stamp (DTS) of the I-frame and the Packet Identification (PID) mapping for the stream. This information allows a decoder to start decoding correctly from the mark point.

To perform trickplay, that is reproducing video with a speed different from the normal playback speed, on a digital video stream of the MPEG2 type as described above, requires extracting and decoding only parts of the video stream and discarding the rest. In many cases, such as for example with DVD, pointers are provided to both the start of the required data and to the end of the required data without parsing the stream. An advantageous method and embodiment will be discussed in case where the end of the required data is not stored, necessitating a reproducing device to parse the stream to find out which parts should be discarded.

If a reproducing device does not know where the end of the trickplay information is in the stream, then a simple approach is to read all the stream data from the start point to the next start point. This increases the amount of device memory required to perform trickplay and increases the performance requirements of a record carrier. The advantageous method and embodiment disclosed hereinafter provides a way to reduce the amount of data that needs to be read from the record carrier and to be stored in a device memory.

Two types of trickplay are considered. The first is one where only I-frames are read from the stream and the second one where I-frames and some P-frames are read. It is assumed that the location of the start of the I-frames are stored but not the end and not any P-frame points.

The basic insight underlying the adavantageous embodiment and method, is that instead of reading a complete Group of Pictures (GOP) to get the I-frame, only a fraction of the GOP is read, based on an estimate for the size of the I-frame. A Groups of Pictures (GOP) is defined in the MPEG2 format (ISO/IEC 13818) and comprised at least one I-frame and one or more P- or B-frames. For example, in a section of a DVD disc, the average I-frame size may be 28 sectors and the average GOP size may be 199 sectors. This leads to choose to read out one quarter (50 sectors) of the GOP to get the I-frame. This is almost twice the average so it could be enough in the worst case. The estimate used should be based on measurements of broadcast streams and may differ for HDTV streams and SD streams.

The same approach works for trickplay using P-frames as well as I-frames. In this case the percentage of the GOP to read will be larger.

From the Characteristic Point Information for trickplay, such as for example disclosed in the International Patent Application with Application Number EP99/08285 (PHN 17161), the Presentation Time Stamp (PTS) of the I-frame and the next I-frame are

known. This enables the calculation the number of frames in a GOP. This may be advantageously used to modify the general estimate for each specific GOP structure.

With this approach it may occur in some cases that the complete I-frame cannot be read. If this happens occasionally, it is no problem. It just means that the trickplay refresh rate will be reduced.

If reading a stream with I-frames that are consistently bigger than estimated, will result in bad looking trickplay performance. To avoid this the algorithm is made adaptive. For example, if it found that two I-frames within a given time period are bigger than estimated, the percentage of the GOP read is increased. If this continues to happen, the percentage of GOP read is increased again. This algorithm should converge very quickly on a value that is big enough. It is also possible to adaptively reduce the amount of data being read. This may be particular useful if P-frames are used for trickplay in a stream without B-frames.

Particular encoders and hence particular streams tend to be very regular in the relative size of the pictures they use. Also encoders normally stick to a fixed GOP size. Therefore, this adaptive approach should be very effective in practice. Using the Presentation Time Stamp (PTS) time in the Characteristic Point Information (CPI) to calculate the number of pictures in the GOP ensures that this method will also work for irregular GOP structures.

Alternatively, the stream could be parsed during record for I-end and the percentage of the GOP to be read on trickplay could be stored to get the I-frame. This value could used as the worst case size or as a value big enough to ensure getting the complete I-frame in 95 % or 99 % of the cases.

This method will work equally well for multiple video streams in a single program. In this case the percentage of the GOP to be read will be the same but actual amount will be larger.

Fig. 9 shows an example of a stream 53 of encoded MPEG2 data, the arrows 50 indicating the entry points stored in the Characteristic Point Information (CPI). Without knowing the I-end points, a reproducing device according to the invention does not need to read until the next entry points 50 during trickplay. Note that the amount 51 of data read depends on the amount of data in the GOP.

Next an advantageous embodiment will be discussed to handle Packet Identification (PID) changes in a recording device when receiving a stream of Information Signal Packets such as MPEG 2 Transport Streams. This may occur for instance with digital TV broadcasts based on MPEG 2 Transport Streams. Packet Identifiers (PIDs) or used to

identify different streams with a multiplex of streams. For example, there may be a PID for video, a PID for audio, a PID for timing information and a PID for teletext information. In the case of a broadcast where there are multiple video streams or audio streams within a single program, there will be a PID for each video stream and for each audio stream. During

5   a digital TV broadcast the PIDs may change with either new PIDs replacing the old PIDs or a change in the correspondence between PIDs and streams. A change in the PID mapping is signaled by Program Association Table (PAT) and Program Map Table (PMT) in the MPEG Transport Stream. Therefore, if the digital TV broadcast is processed as a stream, the decoding device will know when the PIDs change and will know the new PID mapping.

10   It is remarked that according to the MPEG 2 standard, a Program Association Tabel (PAT) maps program identities to their program transport streams. The PAT indicates the PID of the bitstream containing the Program Map Table (PMT) for a program.

A problem is that when a digital TV signal is recorded, it will not always be played back completely from start to finish. The playback device may jump within a stream

15   (random access) or it may select only parts of a stream for decoding (trickplay). Therefore, the playback device may not know that the PID mapping has changed before it starts to decode the stream. For example, during trickplay the audio is normally filtered out of the stream. If the correct PID mapping is not known then it will not be possible to filter the audio and in some cases it could result in the video being filtered instead (if the audio and video

20   PIDs are switched). Also a recording device may introduce additional PID changes due to editing.

The method and embodiment according to the invention comprising storing meta-data about a recording to record the points where the PIDs change. Also the new PID mapping will be stored. For each PID change at least the following information should be

25   stored :

1) the time within the stream where the PIDs change,

2) the location within the stream where the PIDs change, for example by referring to the Transport Stream (TS) packet where the new PIDs are used,

3) the Program Number,

30   4) the Program Clock Reference (PCR) PID,

5) the Video PIDs,

6) the Audio PIDs.

In the case of multiple video streams or multiple audio stream, the correspondence between the streams should be stored. For example, this can be made implicit. The order of the streams in the structure defines their correspondence.

Fig. 10 illustrates the case of random access in an audio or video stream 54,
5   such as an MPEG 2 Transport Stream, after a PID change 55. When the playback device jumps to an entry point 56 in the stream it needs to know the PID mapping to begin decoding and presenting the data. The PAT/PMT tables that define the PID mapping are repeated within the stream but they will not in general be present just before an entry point. By looking up the meta data that records the PID changes, the playback device can see what the
10   correct PIDs are for this part of the program and so multiplex and decode the stream correctly. In the case of multiple video streams or multiple audio streams, the playback device can ensure that it presents the video stream that correctly corresponds to the previous displayed one if applicable. If the stream is being sent over a digital interface then the playback device can use the meta data to insert a new PAT and PMT table to indicate the new
15   PID mapping.

Fig. 11 illustrates trick play of an audio or video stream 57 after a PAT/PMT table change 58. The trick play data to be reproduced is indicated with portions 59. The meta data defining the PID mapping allows the playback device to filter out non-video streams and ensure that the trickplay uses the correct video stream in the case of mutiple video streams. If
20   the trickplay stream is being sent over an interface, then the video PID can be remapped during playback, then when normal play is resumed, the playback device can insert a new PAT and PMT to indicate the new PID mapping.

Although the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus,
25   various modifications thereof may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims. The invention may be implemented by means of both hardware and software, and that several "means" may be represented by the same item of hardware. Further, the invention lies in each and every novel feature or combination of features. It is also remarked that the word "comprising" does not
30   exclude the presence of other elements or steps than those listed in a claim. Any reference signs do not limit the scope of the claims.

CLAIMS:

1.   Method of generating Packet Arrival Timestamps (PAT) of a received real time sequence of information signal packets (TS packet) comprising A/V information, such as MPEG2 Transport Stream packets, the serial sequence comprising at intervals of multiple information signal packets, Program Clock Reference (PCR) information for locking a local

5   System Time Counter (STC) with the Program Clock Reference (PCR) information, the method comprising

determining the packet arrival time of each packet using a packet arrival time counter derived from the local System Time Counter (STC) and

appending a corresponding Packet Arrival Timestamp (PAT) to received

10   information signal packets, characterized by

setting the packet arrival time counter at an arbitrary value before receiving a first information signal packet,

temporally storing the Packet Arrival Timestamp (PAT) of the first information signal packet of the sequence and of the first information signal packet

15   comprising Program Clock Reference (PCR) information,

determining the number of counts of the local System Time Clock Counter (STC) between said Packet Arrival Timestamps (PAT),

subtracting this number from the Program Clock Reference (PCR) value to retrieve a System Time Counter start value (STC-start)

20

2.   Method according to claim 1, wherein the received information signal packets with the appended Packet Arrival Time Stamps (PAT) are stored on a recording medium, wherein, in addition the System Time Counter start value (STC-start) is stored as an attribute of the stored sequence.

25

3.   Method of reproducing a stored real time sequence of information signal packets (TS) comprising A/V information, such as MPEG2 Transport Stream Packets, obtained with the method according to claim 1, the method comprising

running a packet arrival time counter derived from a local System Time Counter (STC),

locking the local System Time Counter (STC) to retrieved Program Clock Reference (PCR) information,

5   retrieving information signal packets and their corresponding Packet Arrival Timestamps (PAT) from a storage medium,

temporally storing a number of retrieved information signal packets,

outputting an information signal packet when the corresponding Packet Arrival Timestamp (PAT) coincides with the packet arrival time counter, characterised by,

10   retrieving the System Time Counter start value (STC-start) from the storage medium,

setting the System Time Counter (STC) with the retrieved System Time Counter start value (STC-start).

15   4.   Method according to claim 3, characterised by, inserting Program Clock Reference (PCR) information corresponding to the System Time Counter start value (STC-start).

5.   Method of reproducing two concatenated sequences of stored real time

20   information signal packets (TS) comprising A/V information, the sequences obtained with the method according to claim 1, wherein a discontinuity in the Packet Arrival Timestamps (PAT) of the two sequences exists at a connection point, no overlap exists between Packet Arrival Timestamps of the two sequences and the decoded corresponding information signal packets are to be presented seamlessly, the method comprising

25   running a presentation time counter derived from a local System Time Counter (STC),

locking the local System Time Counter (STC) to retrieve Program Clock Reference (PCR) information corresponding to either the first or the second sequence,

retrieving packet information signal packets and their corresponding

30   Presentation Timestamps (PTS) from a storage medium,

temporally storing a number of retrieved signal information packets,

presenting an information signal packet when the corresponding Presentation Timestamp (PTS) coincides with the presentation time counter, the method further characterised by,

subtracting the System Time Counter start value (STC-start-2) of the second sequence from the value of the Presentation Timestamp (PTS) of the first information signal packet of the subsequent second sequence,

determine the instant the local System Time Counter (STC) should be set to the value of the System Time Counter start value (STC-start-2).

7.   Apparatus for recording a real time sequence of information signal packets (TS packet) comprising A/V information, such as MPEG2 Transport Stream Packets, on a record carrier, the serial sequence comprising at intervals of multiple information signal packets, Program Clock Reference (PCR) information for locking a local System Time Counter (STC) with the Program Clock Reference (PCR) information, the apparatus comprising

receiving means for receiving the information signal packets,

time stamp generating means for generating a time stamp corresponding to an arrival time of the information signal packets,

writing means for recording the generated time stamps and information signal packets on the record carrier, the time stamp generating means provided with a system time counter locked to the received program clock reference (PCR) information, the apparatus characterized in that,

the time stamp generating means are adapted to generate time stamps according to the method of claim 1.

8.   Apparatus for reproducing a real time sequence of information signal packets (TS packet) comprising A/V information, such as MPEG2 Transport Stream Packets, recorded on a record carrier with the method according to claim 1, the apparatus comprising

reading means for reading the information signal packets recorded on the record carrier,

storing means for temporarily storing a number of information signal packets read from the record carrier,

time stamp generation means comprising a Packet Arrival Time counter derived from a local System Time Counter (STC),

comparator means for comparing a stored time stamp of an information signal packet with the generated Packet Arrival Time value,

outputting an information signal packet from the storing means when a Packet Arrival Time Counter value coincides with the corresponding time stamp, characterized in that,

the time stamp generating means are adapted to generate a Packet Arrival

5   Time according to the method of claim 3.

9.   Method of storing a real time sequence of information signal packets comprising A/V information, such as MPEG 2 Transport Stream Packets, on a record carrier, the sequence comprising Program Clock Reference (PCR) information for locking a local

10   System Time Counter (STC), Presentation Time Stamp (PTS) information for determining the presentation time of the information comprised in the information signal packets, Decoding Time Stamp (DTS) information for determining the decoding time of the information comprised in the information signal packets, and Packet Identification (PID) mapping information , the method comprising adding mark points at specific entry points in

15   the sequence, such as I-frames in MPEG2, characterised by, storing in addition to a mark point one or more of the following information entities: Program Cock Reference (PCR) information, Presentation Time Stamp (PTS) information, Decoding Time Stamp (DTS) information, and Packet Identification (PID) mapping information.

FIG. 1

FIG. 2


FIG. 3

Start
segment

21

First PCR

22

26

First
PTS

Access
unit

Presentation
unit

25

system time clock

Start-up delay

TS packets in the Smoothing buffer

24

23

FIG. 4

PCR

16

27 MHz
VCO

17

STC
Counter

18

Phase
detector

37

LPF

19

Set

APAT
Counter

APAT time stamps

20

FIG. 5

27 End segment   Start segment   28   First PCR
                  31

Last PTS-1e   Access unit   First PTS-2b   Access unit
32   33

Presentation unit

stc-1

set stc-2   stc-2

Presentation unit

T

29

30
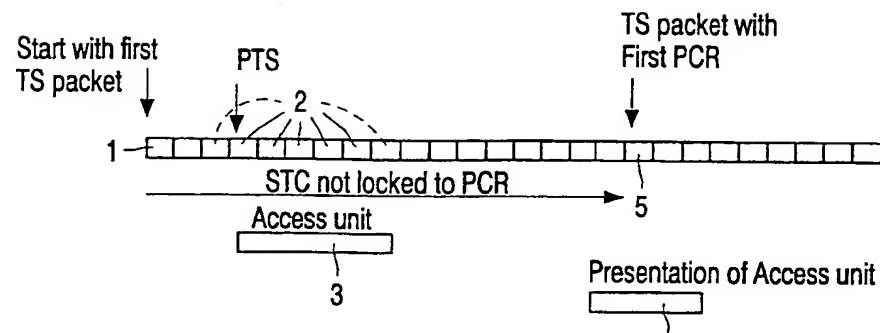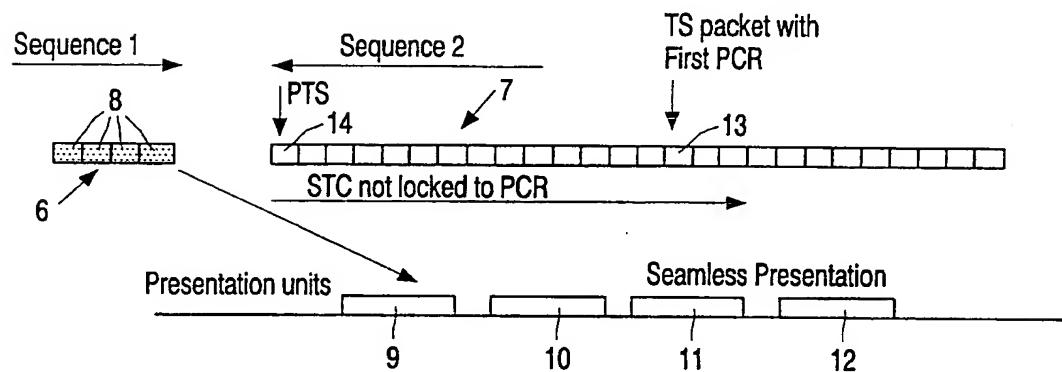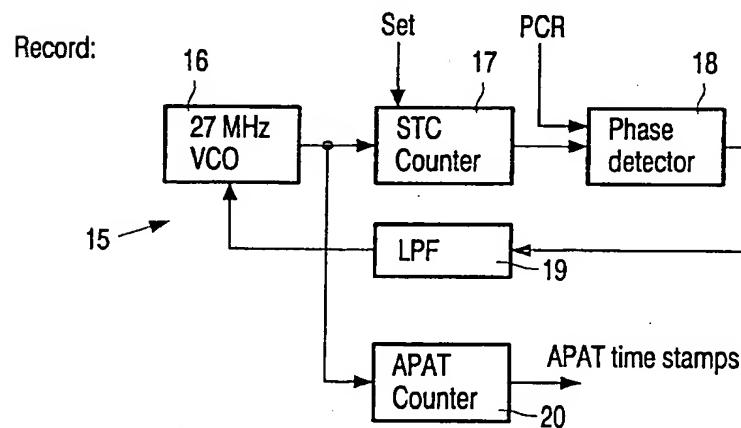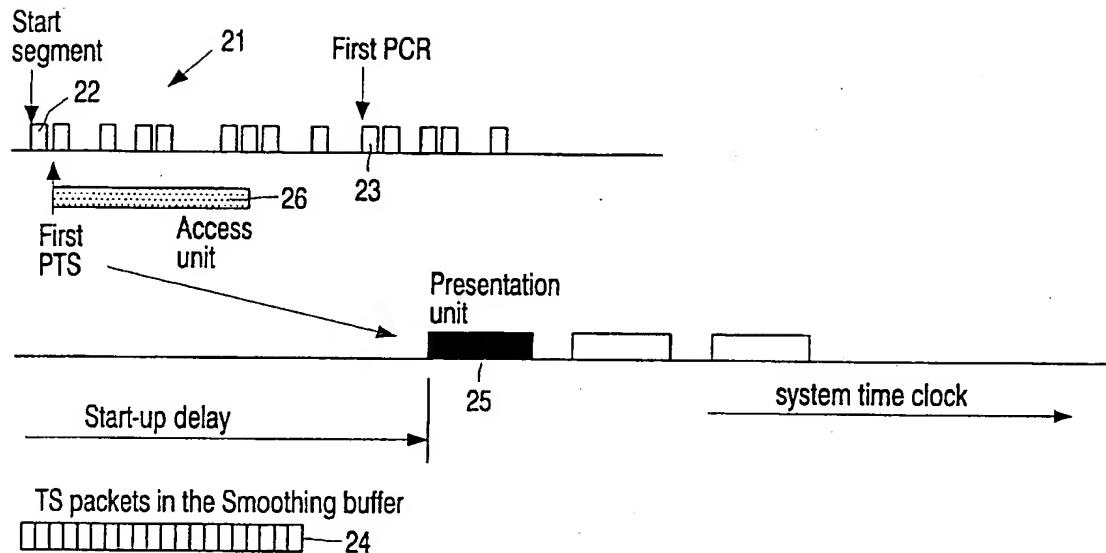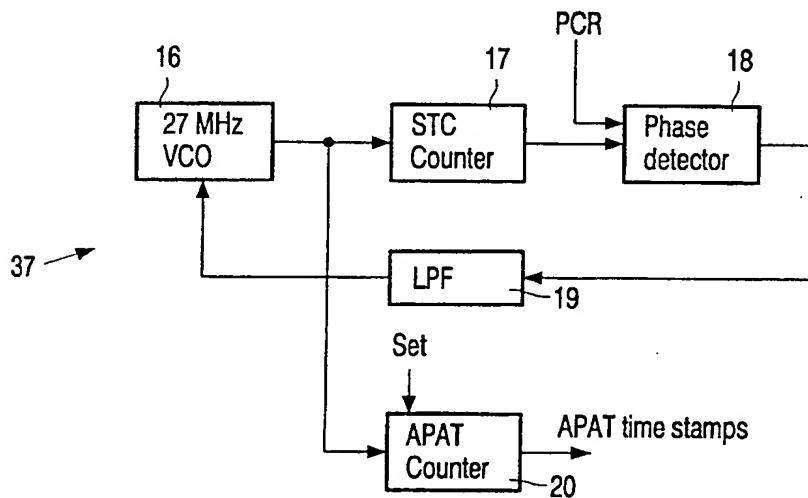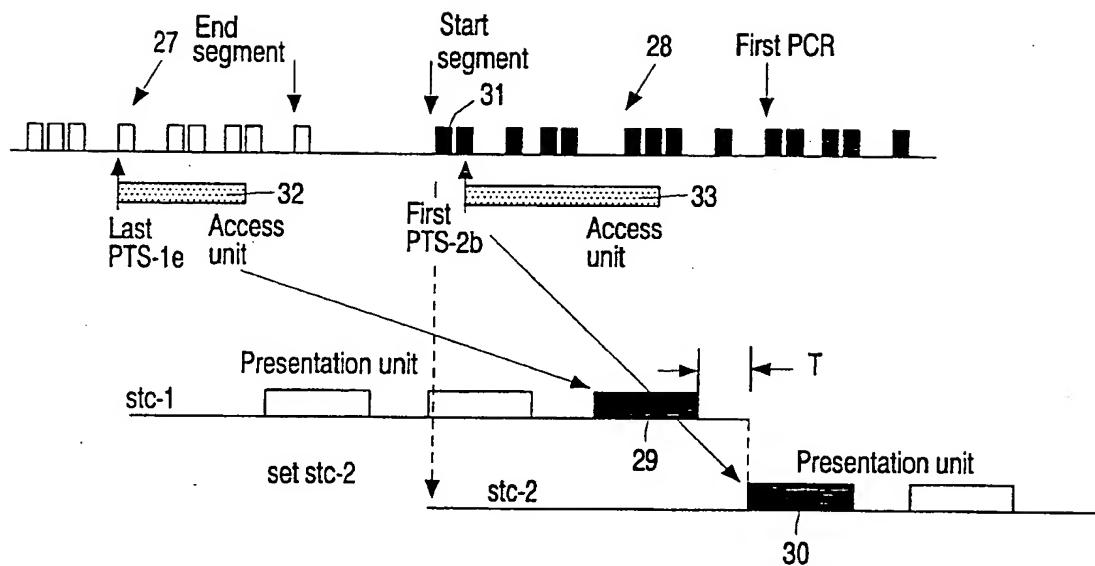
FIG. 6
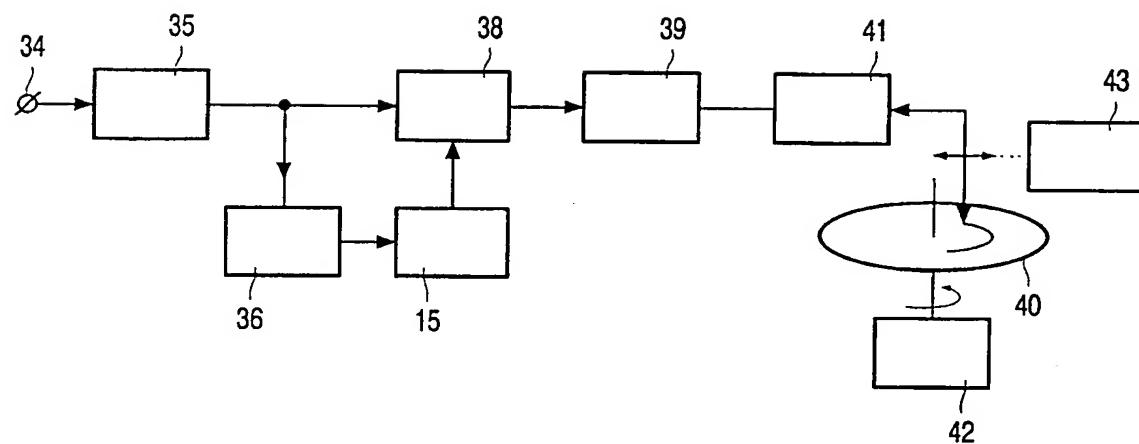
FIG. 7
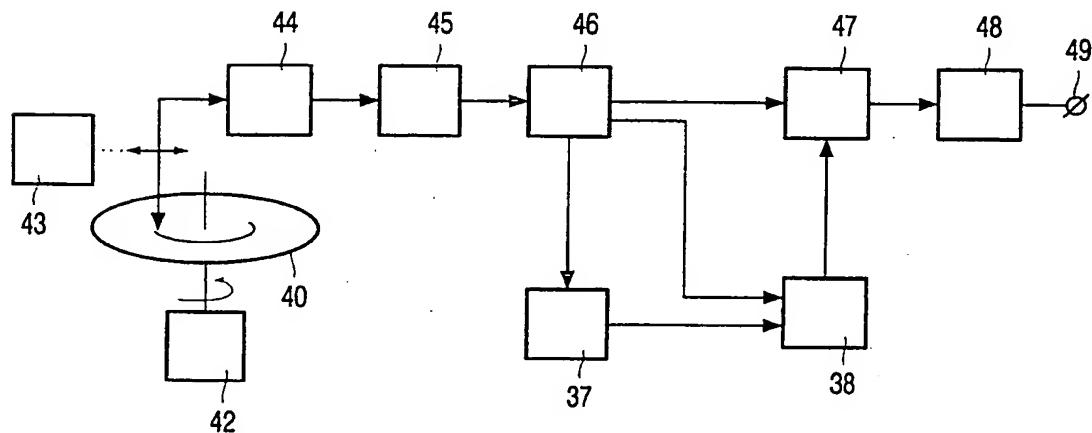
FIG. 8
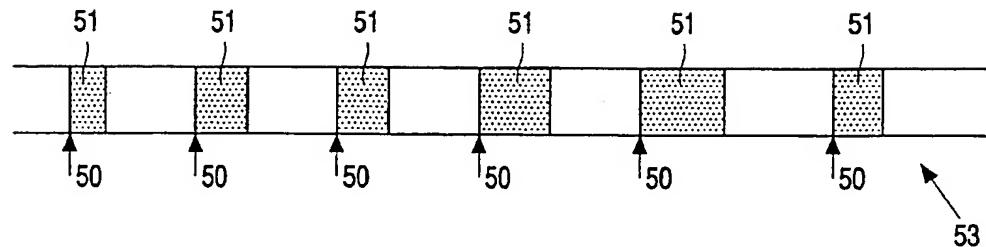
FIG. 9
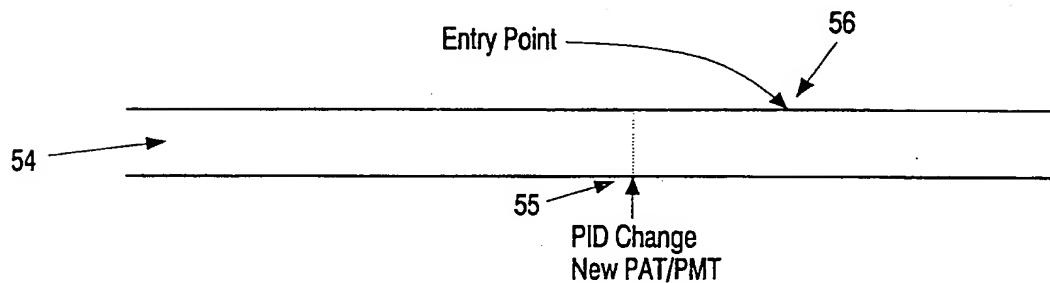
FIG. 10
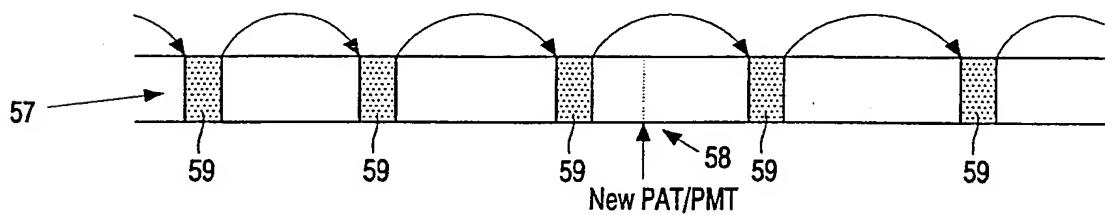
FIG. 11

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04N7/62   H04N5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7   H04N   G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 794 667 A (SONY CORP) 10 September 1997 (1997-09-10) abstract column 15, line 12 - line 36 figures 3,13,16	9
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X	Further documents are listed in the continuation of box C.		X	Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 May 2001	15/05/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Fantini, F

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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